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EP 0615242 A2 EP 0262991 A2 WO 91/15845 A1
JP 080031075 A US 5719985 A US 5646921 A
US 5612933 A US 5237648 A

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(54) Abstract Title
Digital audio or video playback arrangement and method of operation thereof

(57) A digital audio or video playback arrangement for a studio broadcast system is arranged to process a portion of a digital audio or video input stream (100), at a rate faster than real time, additionally to write into mass storage (20) said portion of said input stream whilst reading from mass storage, into eg one or more RAM buffers (401, 402) a previous portion of the digital audio or video input stream or a different digital audio or video input stream. The arrangement enables tracks (F and G) from CDs to be played from hard disk almost instantly with the flexibility and control provided by hard disk systems, but without the associated disadvantages of having to store all tracks in advance. One or more real time output streams (404, 405) can be generated simultaneously from the same CD. Furthermore, the arrangement includes at least one physical control panel and at least one virtual control panel represented on a touch-screen display.

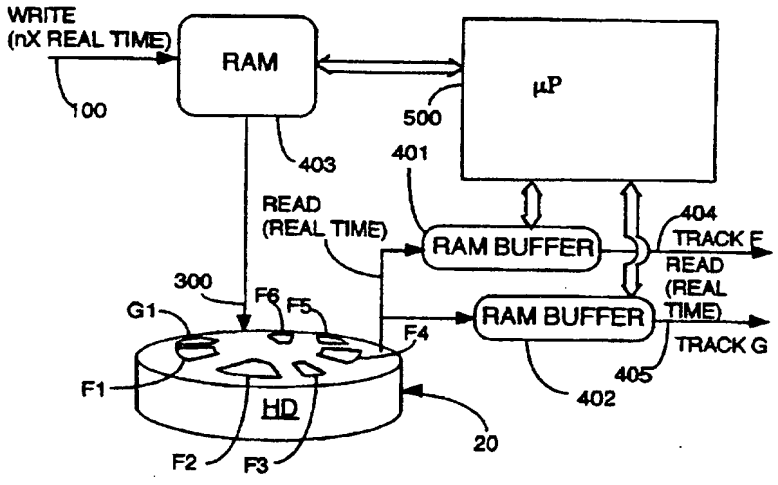


Figure 2

GB 2 343 049 A

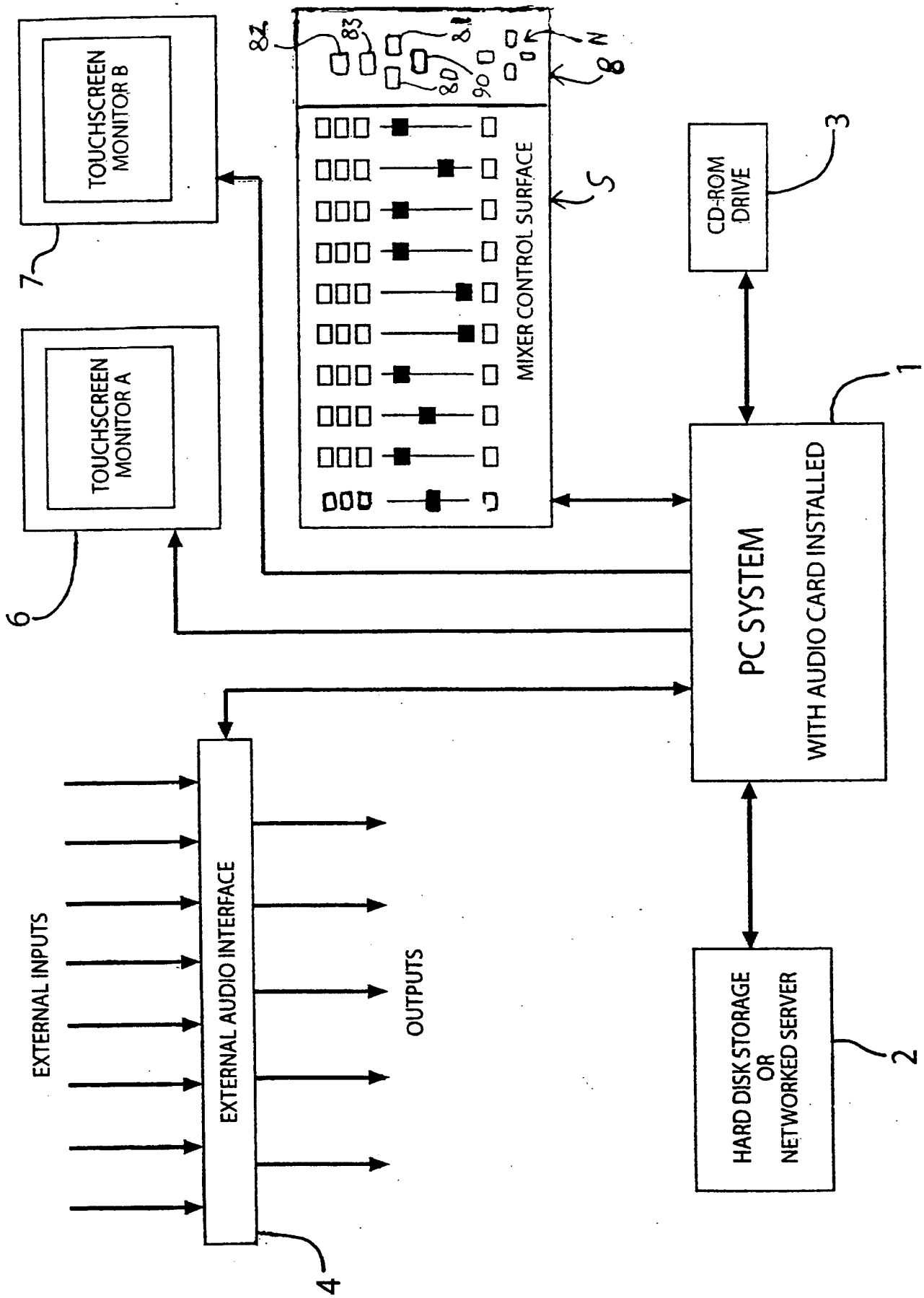

TOUCHSCREEN MONITOR B
TOUCHSCREEN MONITOR A
MIXER CONTROL SURFACE
CD-ROM DRIVE
PC SYSTEM
WITH AUDIO CARD INSTALLED
HARD DISK STORAGE OR NETWORKED SERVER
EXTERNAL AUDIO INTERFACE
EXTERNAL INPUTS
OUTPUTS
1
2
3
4
5
6
7
8
82
83
81
80
90
N

FIGURE 1

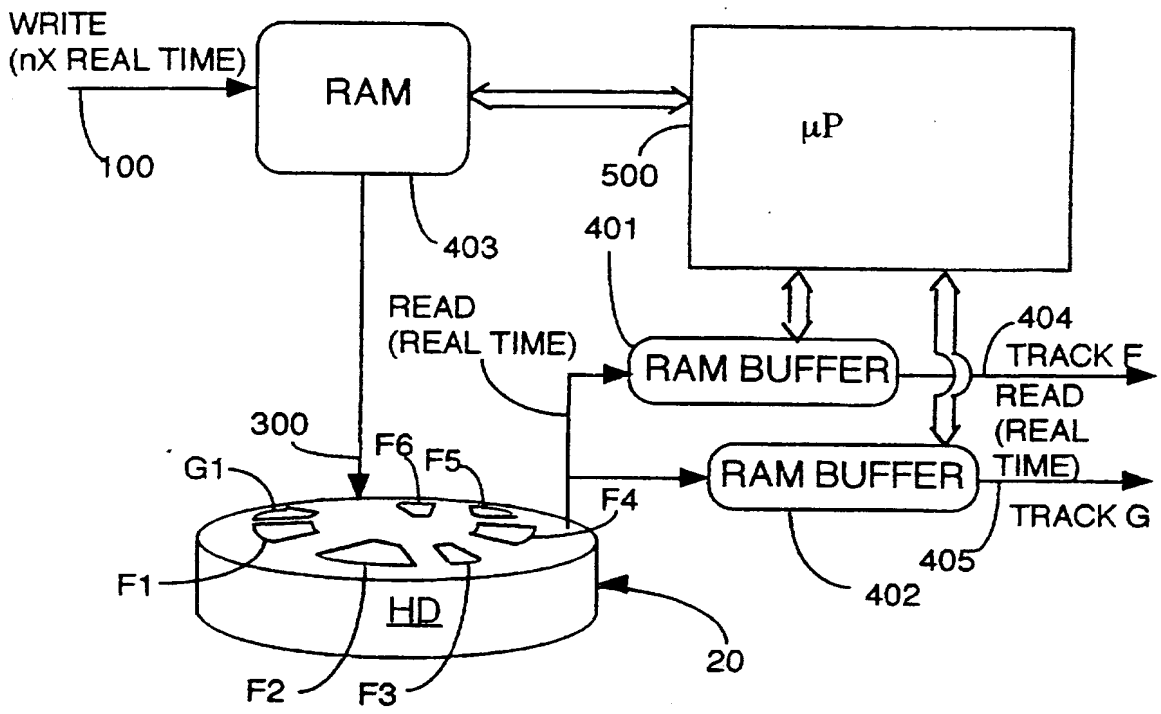
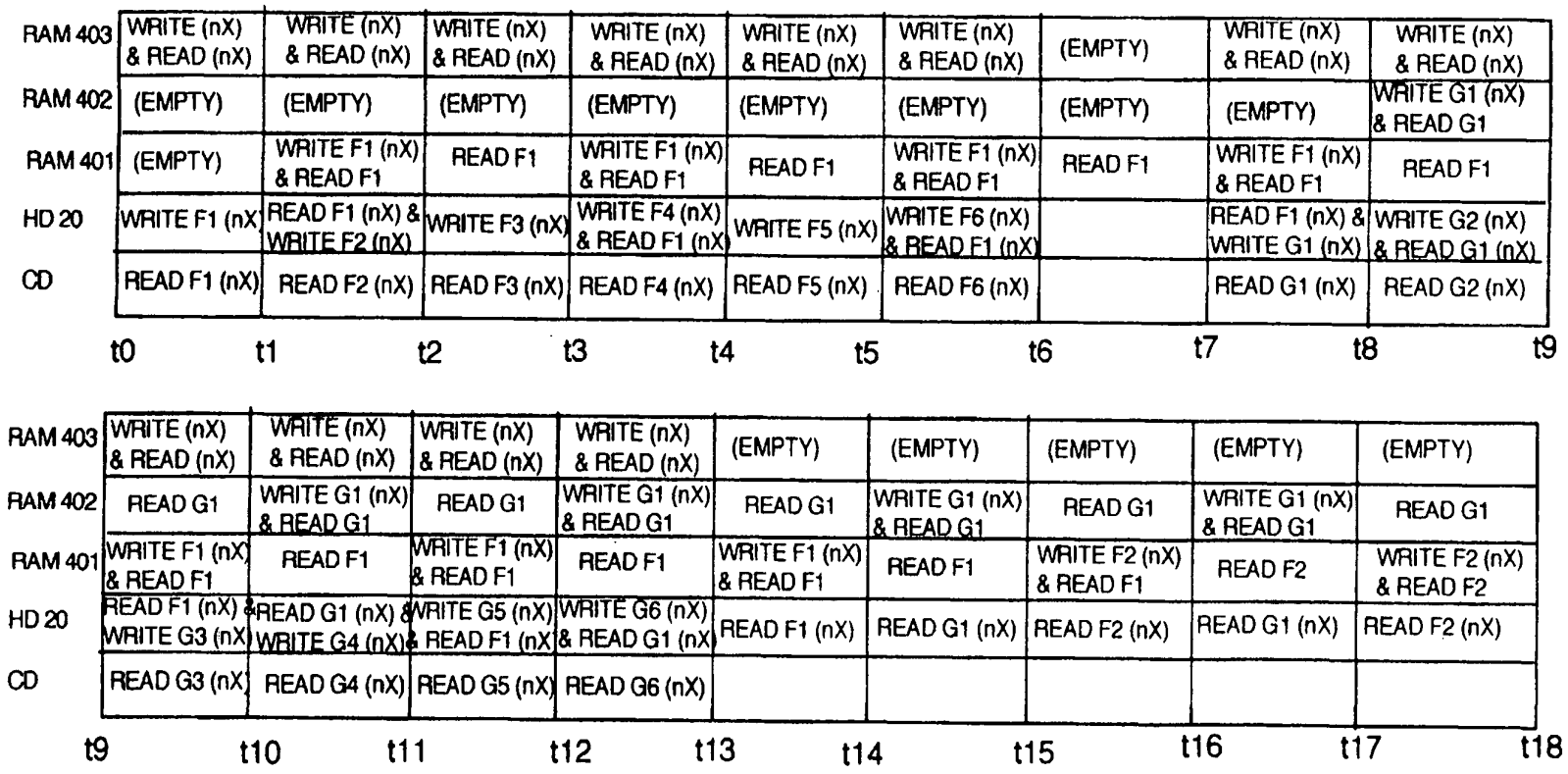

WRITE
(nX REAL TIME)
100
RAM
500
μP
403
401
READ
(REAL TIME)
RAM BUFFER
404
TRACK F
READ
(REAL
TIME)
300
F6
F5
G1
RAM BUFFER
TRACK G
F4
405
F1
HD
402
20
F2
F3

Figure 2


RAM 403
RAM 402
RAM 401
HD 20
CD
WRITE (nX) & READ (nX)
(EMPTY)
WRITE F1 (nX) & READ F1
READ F1
WRITE F1 (nX)
READ F1 (nX) & WRITE F2 (nX)
WRITE F3 (nX)
WRITE F4 (nX) & READ F1 (nX)
WRITE F5 (nX)
WRITE F6 (nX) & READ F1 (nX)
READ F1 (nX)
READ F2 (nX)
READ F3 (nX)
READ F4 (nX)
READ F5 (nX)
READ F6 (nX)
WRITE G1 (nX) & READ G1
READ F1 (nX) & WRITE G1 (nX)
WRITE G2 (nX) & READ G1 (nX)
READ G1 (nX)
READ G2 (nX)
t0
t1
t2
t3
t4
t5
t6
t7
t8
t9

RAM 403
RAM 402
RAM 401
HD 20
CD
WRITE (nX) & READ (nX)
READ G1
WRITE G1 (nX) & READ G1
WRITE F1 (nX) & READ F1
READ F1
WRITE F2 (nX) & READ F1
READ F2
WRITE F2 (nX) & READ F2
READ F1 (nX) & WRITE G3 (nX)
READ G1 (nX) & WRITE G4 (nX)
WRITE G5 (nX) & READ F1 (nX)
WRITE G6 (nX) & READ G1 (nX)
READ F1 (nX)
READ G1 (nX)
READ F2 (nX)
READ G1 (nX)
READ F2 (nX)
READ G3 (nX)
READ G4 (nX)
READ G5 (nX)
READ G6 (nX)
t9
t10
t11
t12
t13
t14
t15
t16
t17
t18

Figure 3A

	t0	t1	t2	t3	t4	t5	t6	t7	t8	t9
RAM 403	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	(EMPTY)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	
RAM 402	(EMPTY)	(EMPTY)	(EMPTY)	(EMPTY)	(EMPTY)	(EMPTY)	(EMPTY)	(EMPTY)	(EMPTY)	
RAM 401	(EMPTY)	WRITE F1 (nX) & READ F1	READ F1	WRITE F1 (nX) & READ F1	READ F1	WRITE F1 (nX) & READ F1	READ F1	WRITE F1 (nX) & READ F1	READ F1	
HD 20	WRITE F1 (nX)	READ F1 (nX) & WRITE F2 (nX)	RE-WRITE F2 (n'X)	RE-WRITE F2 (nX) & READ F1 (nX)	RE-WRITE F2 (n'X)	WRITE F3 (nX) & READ F1 (nX)	WRITE F4 (nX)	READ F1 (nX) & WRITE F5 (nX)	WRITE F6(nX)	
CD	READ F1 (nX)	READ F2 (nX)	RE-READ F2 (n'X)	RE-READ F2 (n'X)	RE-READ F2 (n'X)	READ F3 (nX)	READ F4 (nX)	READ F5 (nX)	READ F6 (nX)	

	t9	t10	t11	t12	t13	t14	t15	t16	t17	t18
RAM 403	(EMPTY)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	WRITE (nX) & READ (nX)	(EMPTY)	(EMPTY)	
RAM 402	(EMPTY)	(EMPTY)	WRITE G1 (nX) & READ G1	READ G1	WRITE G1 (nX) & READ G1	READ G1	WRITE G1 (nX) & READ G1	READ G1	WRITE G1 (nX) & READ G1	
RAM 401	WRITE F1 (nX) & READ F1	READ F1	WRITE F1 (nX) & READ F1	READ F1	WRITE F1 (nX) & READ F1	READ F1	WRITE F2 (nX) & READ F1	READ F2	WRITE F2 (nX) & READ F2	
HD 20	READ F1 (nX)	WRITE G1 (nX)	WRITE G2 (nX) READ F1(nX) & READ G1	WRITE G3 (nX)	WRITE G4 (nX) READ F1(nX) & READ G1	READ G5 (nX)	WRITE G8 (nX) READ F2(nX) & READ G1		READ F2 (nX) & READ G1 (nX)	
CD		READ G1 (nX)	READ G2 (nX)	READ G3 (nX)	READ G4 (nX)	READ G5 (nX)	READ G6 (nX)			

Figure 3B

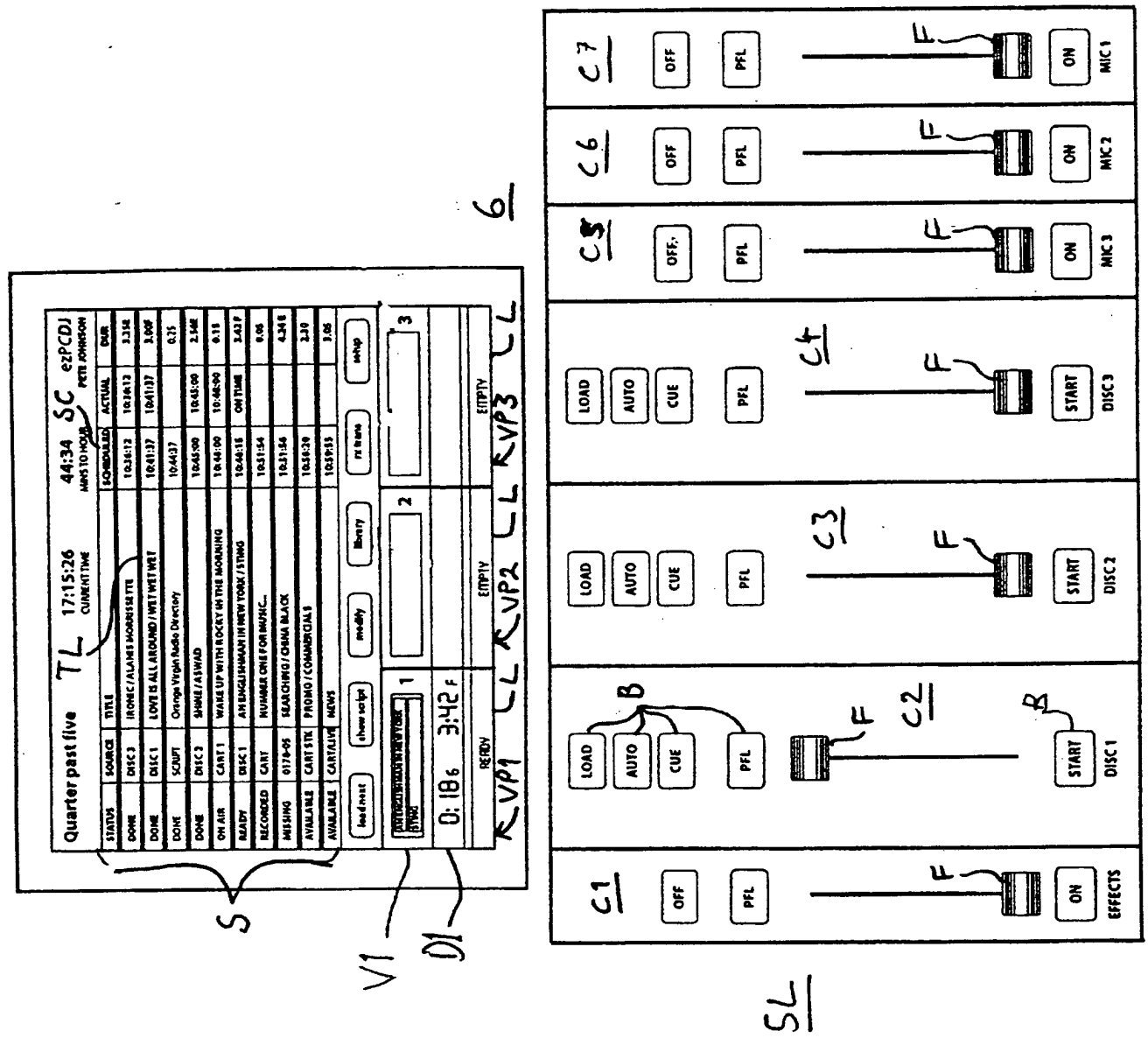

Quarter past five
TL
17:15:26
CURRENT TIME
44:34
MINS TO HOUR
SC
ezPCDJ
PETE JOHNSON
STATUS
SOURCE
TITLE
SCHEDULED
ACTUAL
DUR
DONE DISC 3 IRONIC / ALANIS MORRISSETTE 10:36:12 10:36:12 3.35
DONE DISC 1 LOVE IS ALL AROUND / WET WET WET 10:41:37 10:41:37 3.09
DONE SCRIPT Chrisps Virgin Radio Directory 10:44:37 0.25
DONE DISC 2 SHAKE / ASWAD 10:45:00 10:45:00 2.58
ON AIR CART 1 WAKE UP WITH ROCKY IN THE MORNING 10:48:00 10:48:00 0.15
READY DISC 1 AMERICA/HAMMER IN NEW YORK / STING 10:48:15 ON TIME 3.03
RECORDED CART NUMBER ONE FOR MUSIC... 10:51:54 0.05
MISSING 0176-05 SEARCHING / CHINA BLACK 10:51:56 4.34
AVAILABLE CART STK PROMO / COMMERCIALS 10:56:30 2.30
AVAILABLE CARTWALL NEWS 10:59:33 3.05
loadpost
show script
modify
library
retrieve
setup
1
2
3
0: 18
3:42
RETRY
EMPTY
EMPTY
KVP1
KVP2
KVP3
S
V1
D1
6
C1
C2
C3
C4
C5
C6
C7
OFF
PFL
LOAD
AUTO
CUE
START
ON
B
F
DISC 1
DISC 2
DISC 3
MIC 3
MIC 2
MIC 1
EFFECTS
SL

Figure 4

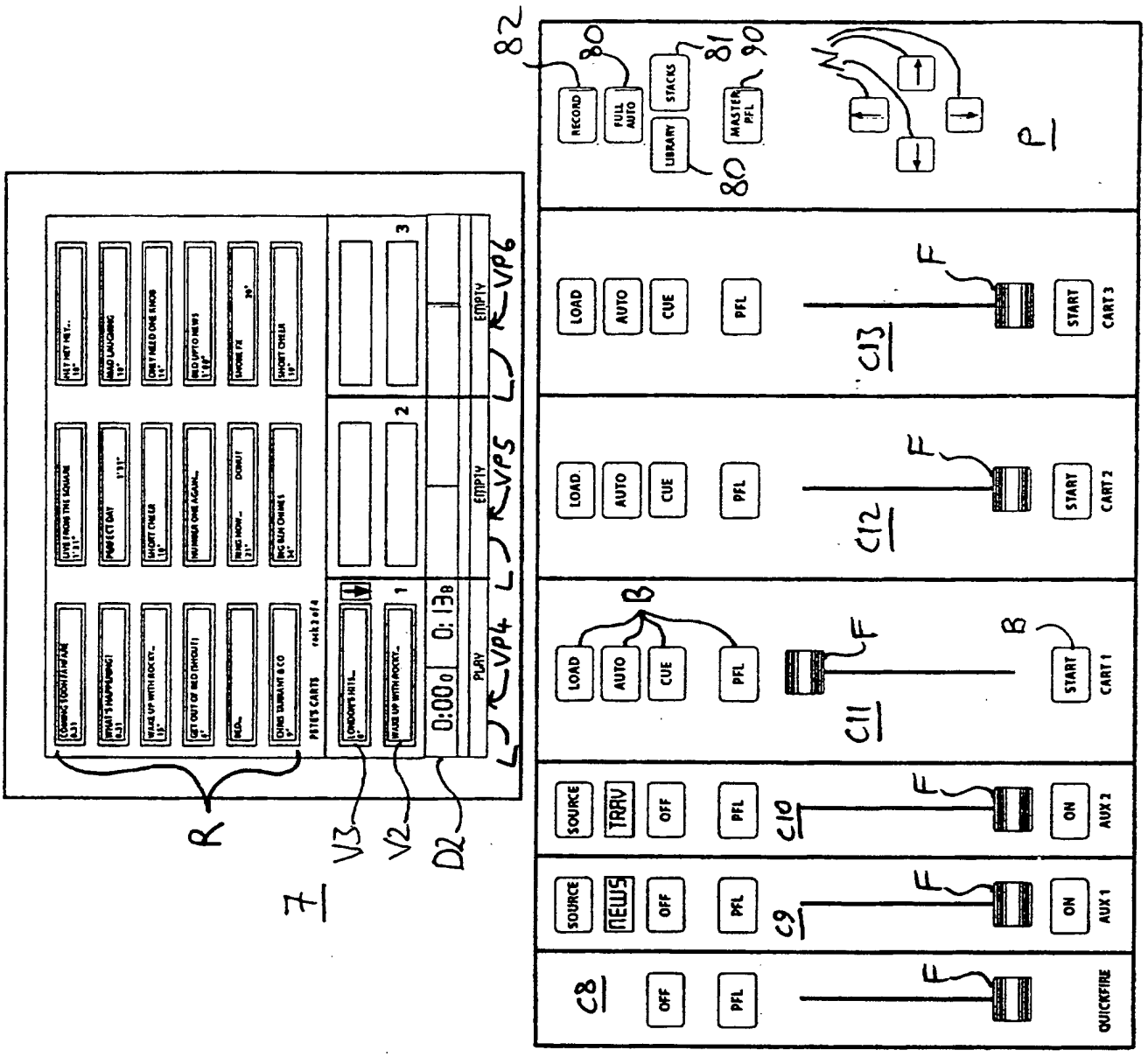

82
80
81
90
RECORD
FULL AUTO
STACKS
LIBRARY
MASTER PFL
P1
LOAD
AUTO
CUE
PFL
START
CART 3
CART 2
CART 1
C13
C12
C11
F
B
SOURCE
TRAV
OFF
ON
AUX 2
AUX 1
C10
C9
C8
QUICKFIRE
SR
R
V3
V2
D2
VP4
VP5
VP6
EMPTY
PLAY
PETES CARTS
0:00
0:13
7

Figure 5

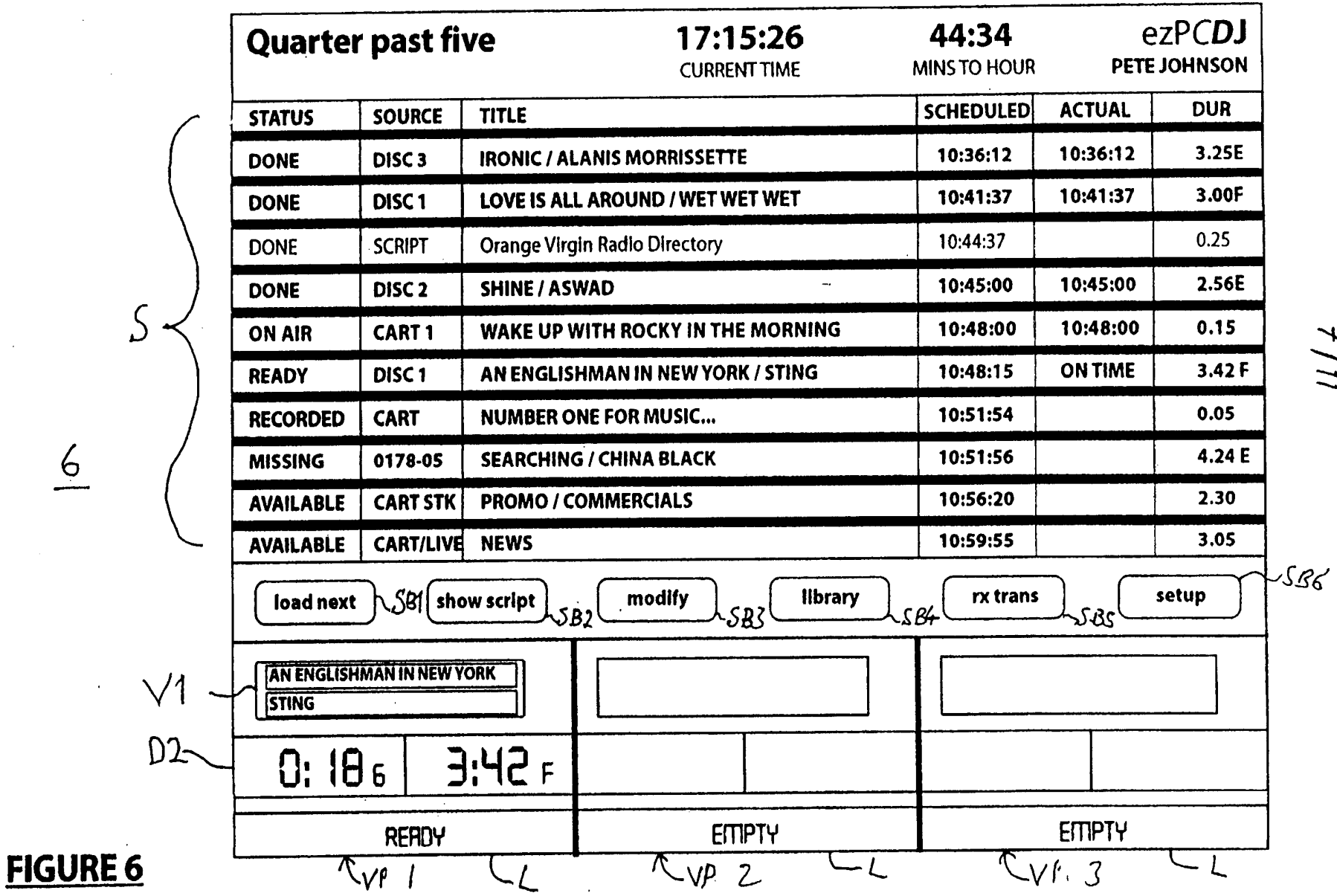

Quarter past five
17:15:26
CURRENT TIME
44:34
MINS TO HOUR
ezPCDJ
PETE JOHNSON
STATUS
SOURCE
TITLE
SCHEDULED
ACTUAL
DUR
DONE
DISC 3
IRONIC / ALANIS MORRISSETTE
10:36:12
10:36:12
3.25E
DONE
DISC 1
LOVE IS ALL AROUND / WET WET WET
10:41:37
10:41:37
3.00F
DONE
SCRIPT
Orange Virgin Radio Directory
10:44:37
0.25
DONE
DISC 2
SHINE / ASWAD
10:45:00
10:45:00
2.56E
ON AIR
CART 1
WAKE UP WITH ROCKY IN THE MORNING
10:48:00
10:48:00
0.15
READY
DISC 1
AN ENGLISHMAN IN NEW YORK / STING
10:48:15
ON TIME
3.42 F
RECORDED
CART
NUMBER ONE FOR MUSIC...
10:51:54
0.05
MISSING
0178-05
SEARCHING / CHINA BLACK
10:51:56
4.24 E
AVAILABLE
CART STK
PROMO / COMMERCIALS
10:56:20
2.30
AVAILABLE
CART/LIVE
NEWS
10:59:55
3.05
S
6
load next
SB1
show script
SB2
modify
SB3
library
SB4
rx trans
SB5
setup
SB6
V1
AN ENGLISHMAN IN NEW YORK
STING
D2
0: 18 6
3:42 F
READY
EMPTY
EMPTY
VP 1
VP 2
VP 3
L
L
L
7/11

FIGURE 6

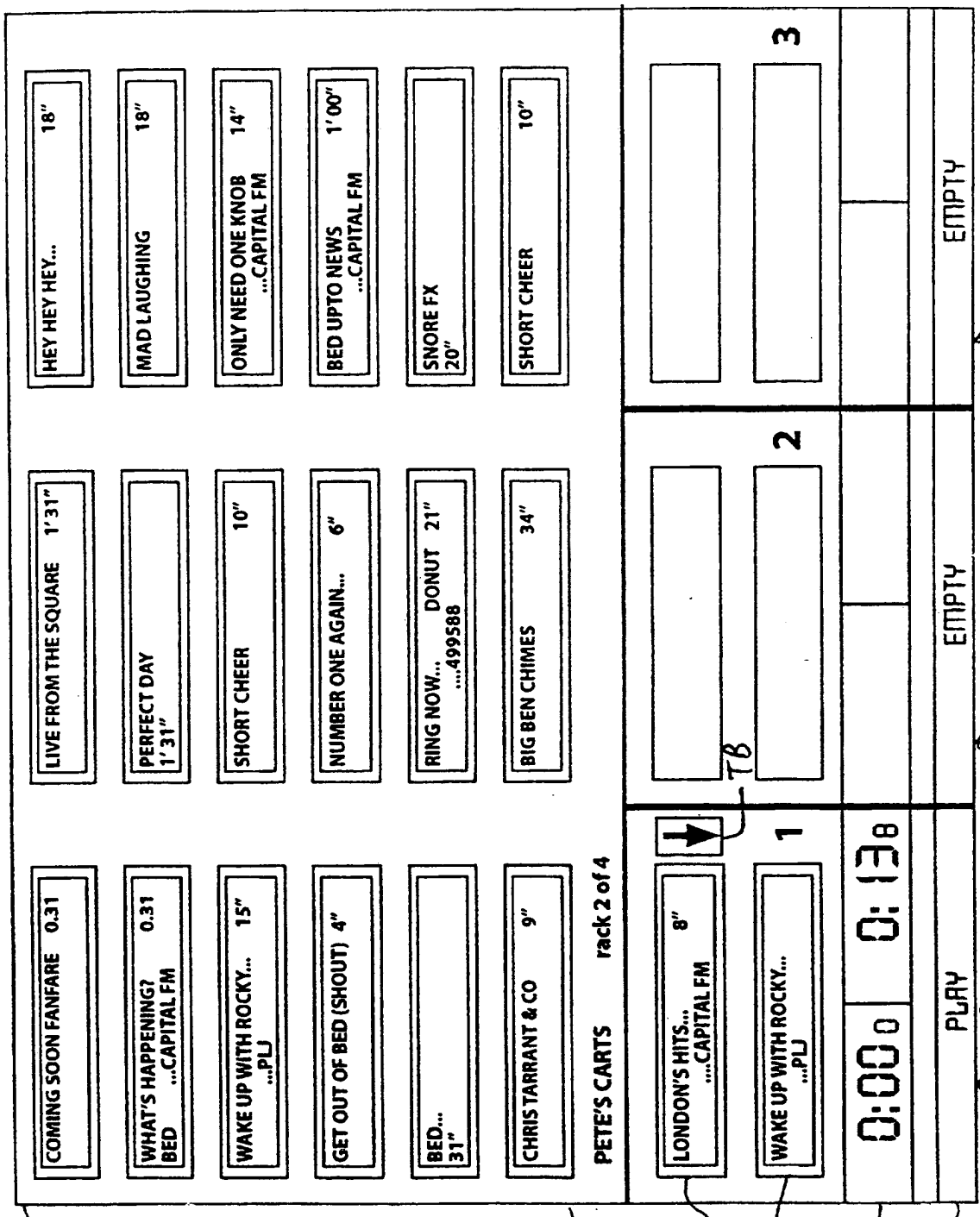

COMING SOON FANFARE 0.31
WHAT'S HAPPENING? 0.31
BED ...CAPITAL FM
WAKE UP WITH ROCKY... 15"
...PLJ
GET OUT OF BED (SHOUT) 4"
BED... 31"
CHRIS TARRANT & CO 9"
LIVE FROM THE SQUARE 1'31"
PERFECT DAY 1'31"
SHORT CHEER 10"
NUMBER ONE AGAIN... 6"
RING NOW... DONUT 21"
....499588
BIG BEN CHIMES 34"
HEY HEY HEY... 18"
MAD LAUGHING 18"
ONLY NEED ONE KNOB 14"
...CAPITAL FM
BED UPTO NEWS 1'00"
...CAPITAL FM
SNORE FX 20"
SHORT CHEER 10"
PETE'S CARTS rack 2 of 4
LONDON'S HITS... 8"
....CAPITAL FM
WAKE UP WITH ROCKY...
...PLJ
0:00 0 0:13 8
PLAY
EMPTY
EMPTY
1
2
3
T8
R
7
V3
V2
D2
L
VP4
VP5
VP6

Figure 7

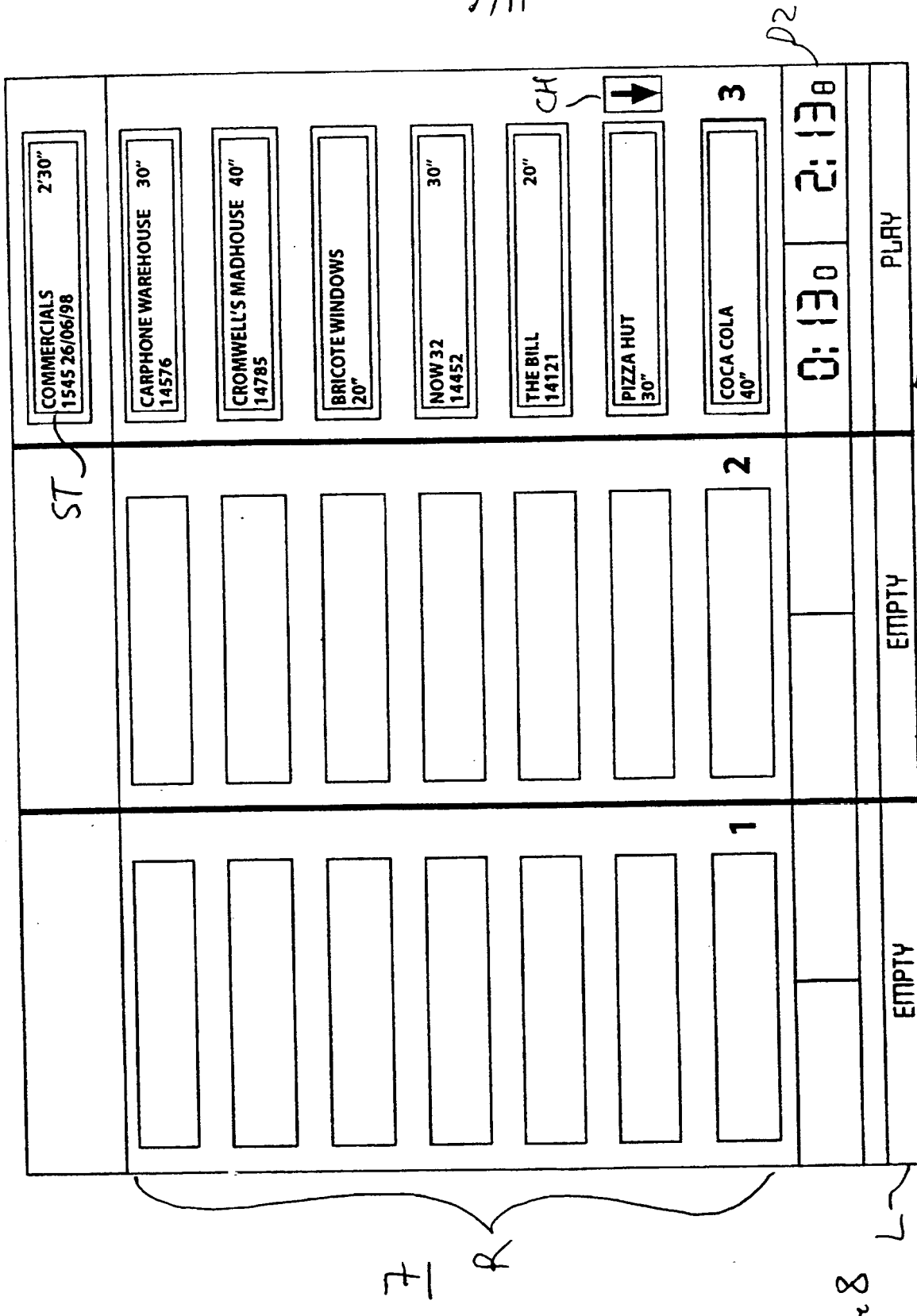

D2
CH
3
2
1
ST
COMMERCIALS 2'30" 1545 26/06/98
CARPHONE WAREHOUSE 30" 14576
CROMWELL'S MADHOUSE 40" 14785
BRICOTE WINDOWS 20"
NOW 32 30" 14452
THE BILL 20" 14121
PIZZA HUT 30"
COCA COLA 40"
0:13 0
2:13 8
PLAY
EMPTY
EMPTY
VP6
VP5
VP4
7
R

Figure 8

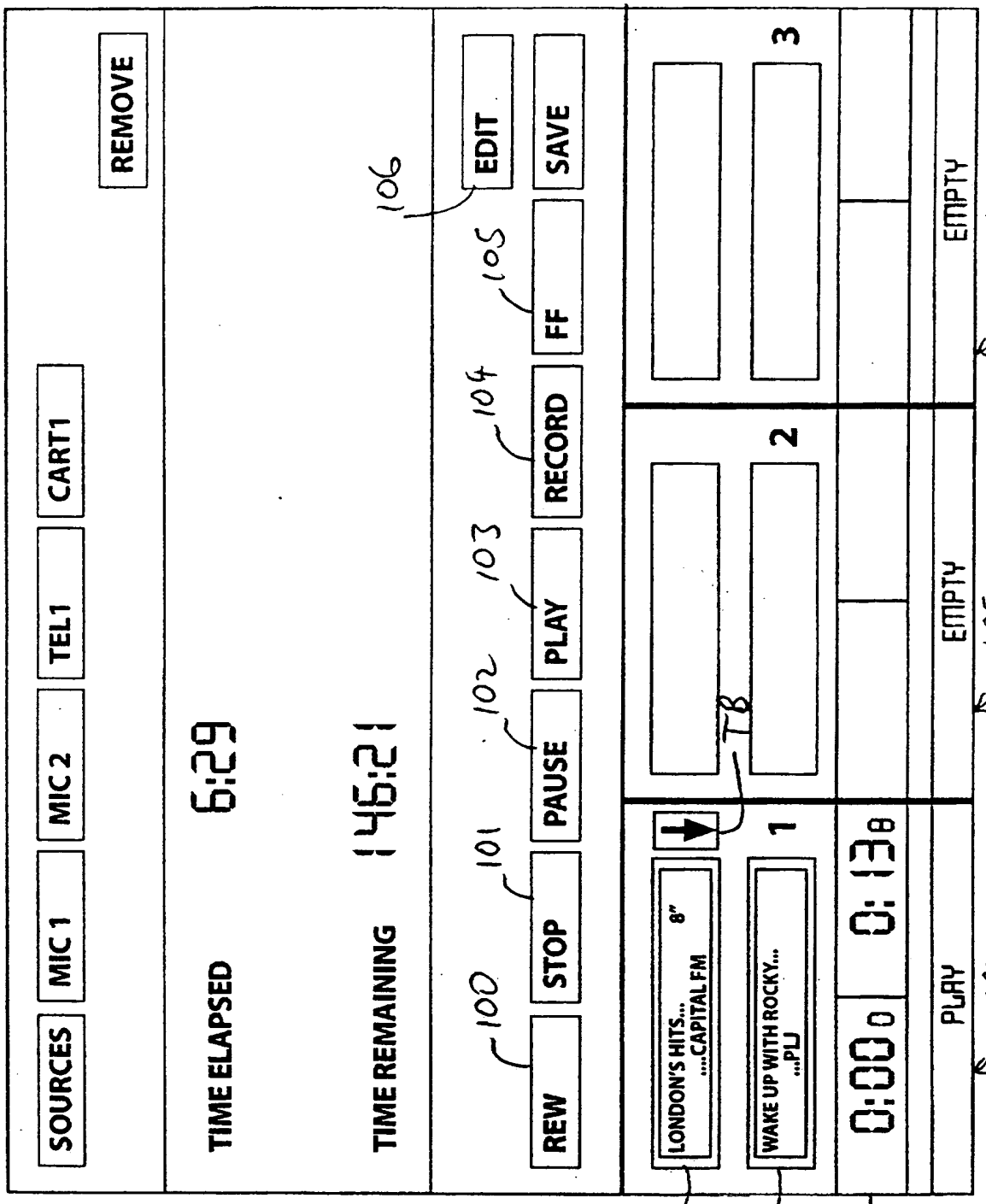

SOURCES
MIC 1
MIC 2
TEL1
CART1
REMOVE
TIME ELAPSED
6:29
TIME REMAINING
146:21
106
EDIT
SAVE
105
FF
104
RECORD
103
PLAY
102
PAUSE
101
STOP
100
REW
LONDON'S HITS... ....CAPITAL FM
8"
WAKE UP WITH ROCKY... ...PLJ
T8
1
2
3
0:00 0
0:13 8
PLAY
EMPTY
EMPTY
V3
V2
D2
VP4
VP5
VP6

Figure 9

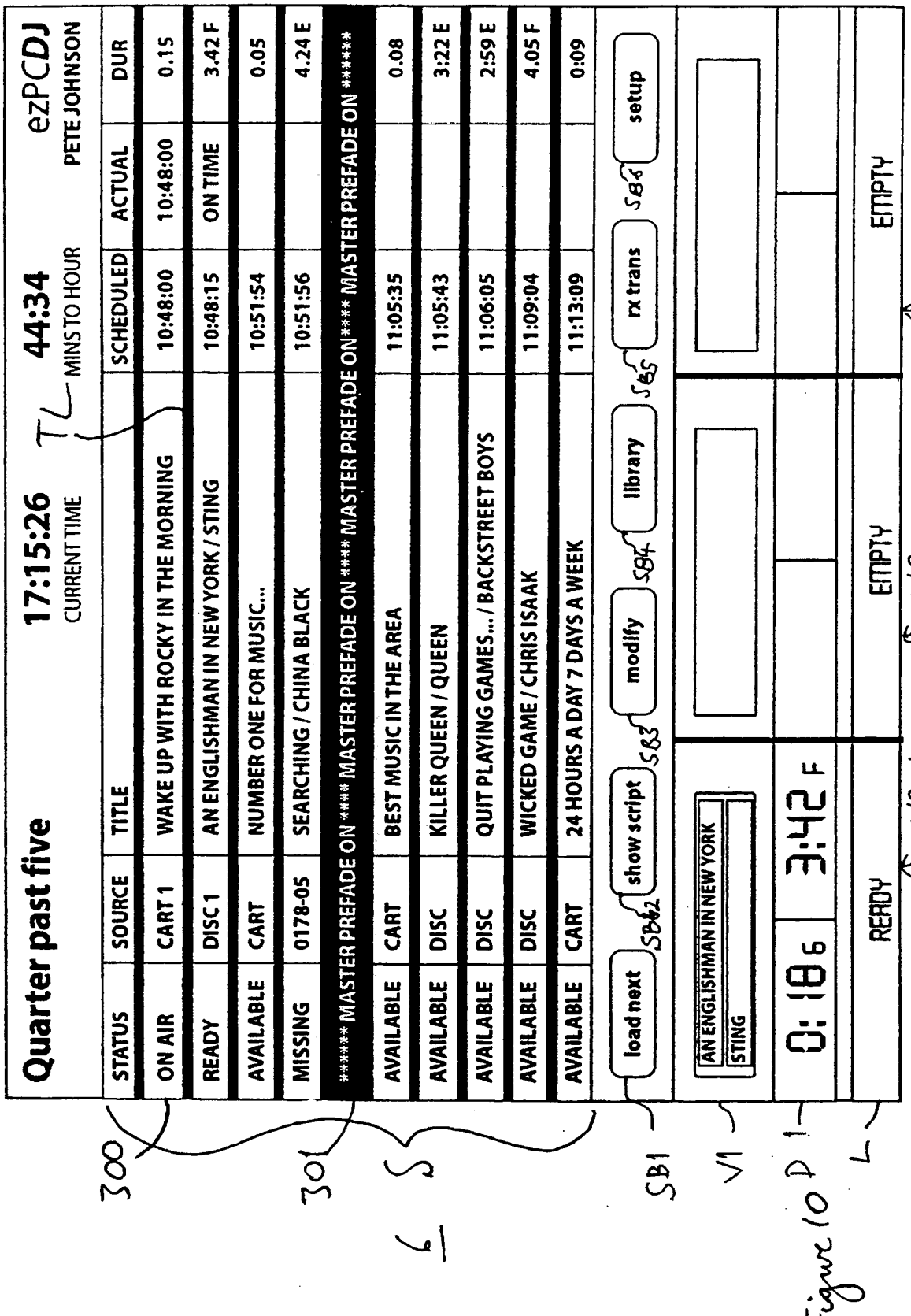

Quarter past five
17:15:26
CURRENT TIME
44:34
MINS TO HOUR
ezPCDJ
PETE JOHNSON
STATUS | SOURCE | TITLE | SCHEDULED | ACTUAL | DUR
ON AIR | CART 1 | WAKE UP WITH ROCKY IN THE MORNING | 10:48:00 | 10:48:00 | 0.15
READY | DISC 1 | AN ENGLISHMAN IN NEW YORK / STING | 10:48:15 | ON TIME | 3.42 F
AVAILABLE | CART | NUMBER ONE FOR MUSIC... | 10:51:54 | | 0.05
MISSING | 0178-05 | SEARCHING / CHINA BLACK | 10:51:56 | | 4.24 E
******* MASTER PREFADE ON **** MASTER PREFADE ON **** MASTER PREFADE ON**** MASTER PREFADE ON ******
AVAILABLE | CART | BEST MUSIC IN THE AREA | 11:05:35 | | 0.08
AVAILABLE | DISC | KILLER QUEEN / QUEEN | 11:05:43 | | 3:22 E
AVAILABLE | DISC | QUIT PLAYING GAMES... / BACKSTREET BOYS | 11:06:05 | | 2:59 E
AVAILABLE | DISC | WICKED GAME / CHRIS ISAAK | 11:09:04 | | 4.05 F
AVAILABLE | CART | 24 HOURS A DAY 7 DAYS A WEEK | 11:13:09 | | 0:09
load next
show script
modify
library
rx trans
setup
AN ENGLISHMAN IN NEW YORK
STING
0:18 6
3:42 F
READY
EMPTY
EMPTY
300
301
SB1
SB2
SB3
SB4
SB5
SB6
VP 1
VP 2
VP 3
V1
P1
L

Figure 10

Digital Audio/Video Playback Arrangement and Method of Operation thereof

The present invention relates to a digital audio and/or video playback arrangement, particularly but not exclusively for broadcasting, and to a method of operation thereof. The invention is applicable both to audio and to video playback.

Ever since the introduction of the CD, digital recording has made a huge impact on the broadcast radio market. Few stations still play vinyl records and the NAB jingle cartridge has been replaced by digital floppy disk players and cheaper, maintenance free PC hard disk systems. Computer based music scheduling has become the norm at most stations and hard disk systems used for playing music have the advantages over CD's of instant access and the potential for automation.

In theory these developments should make systems easier to use, enabling audio material to be accessed quickly and making the disc jockey's life easier by increased automation.

In reality the situation is somewhat different.

The chief reason for this is that as components have evolved and replaced existing equipment the result is more computer keyboards, more screens to look at and more opportunities for mistakes to be made. The disc jockey can end up spending more time sorting out the sheer mechanics of the show than working on the show's content.

In the US, hard disk systems are becoming common for playing music but as stations are more specialised and play fewer tracks the disk storage requirements are not a problem.

In the UK market, stations tend to play a greater variety of music so the sheer amount of disk storage required to hold a radio station's CD collection makes the concept unworkable.

Throughout this transformation into the digital age, the mixing desk has remained largely unchanged.

In particular, in one current CD-based studio, CDs are played from conventional CD players of which there are typically three. This allows one CD to play on-air, the next track to be standing by and a third player as a spare. Commercials and jingles are commonly played from a PC based hard disk system. This gives the disc jockey

quick access to material and also allows logs of which items were played to be generated automatically. There are also various outside feeds such as Travel News, Newsroom and other studios in the station.

All the above sources are fed through a conventional analogue audio mixer for balancing of levels. This also allows remote start of the CD players and the ability to hear a source on prefade - i.e. to hear a mixer channel without it being broadcast on air.

The above system has the advantages of ease of use and being tried and trusted. However it is relatively expensive, has limited automation potential and the disc jockey has to locate and load all CD's to play.

Conversely, in a hard disk - based studio, all music tracks are played from a PC based hard disk system, not directly from CD. Commercials and jingles are also played from the same hard disk system. There are various outside feeds such as Travel News, Newsroom and other studios in the station.

All the above sources are fed through a conventional analogue audio mixer for balancing of levels. This allows remote start of the hard disk players and the ability to hear a source on prefade though this can be limited as the hard disk system commonly only has two or three stereo outputs.

Such a hard disk system has the advantages that music tracks are instantly available, tracks from the same CD can be played back to back, automation is easier to implement and it can be fully integrated with a scheduling system.

It has the disadvantages that all music has to be loaded into the system in advance, it can be expensive, since more storage will need to be added as the station's library grows and it is inefficient because 40% of the tracks may only get played once every six months. Furthermore because such a system is inherently computer and mouse based, it can be less satisfying to use and the disk jockey can feel out of control.

The complexity of a television studio is even greater, placing even greater demands on the presenters and technicians.

An object of the present invention is to overcome or alleviate at least some of the above disadvantages.

In one aspect the invention provides a digital audio or video playback arrangement arranged to process a digital audio or video input stream and to write at least a

portion of the processed digital input stream into mass storage at a rate faster than real time, to read from mass storage at a rate faster than real time a previously written portion of the same or a different digital audio or video input stream and to read out via buffer means in real time said previously written portion.

In a related aspect the invention provides a digital audio or video playback arrangement arranged to write to mass storage, at a rate faster than real-time, a digital audio or video input stream from a removable data carrier, and simultaneously to output at least one audio or video output stream, said output stream being derived from the same or a different digital audio or video input stream previously written to the mass storage.

Preferably the arrangement is arranged to write successive portions of the digital audio or video input stream to separate files, to read out said files from mass storage and to combine them into a real-time output stream.

In this manner a small portion (say the equivalent of 10 seconds to one minute in real time) of the audio or video can be recorded very quickly (in say half a second to 3 seconds if written at 20x) and then played back. ie in a time comparable to the delay before playback from a conventional CD player.

Preferably the files are processed individually before being combined into the output stream.

By processing (eg to detect the maximum level or to detect faults such as a scratch in a CD from which the input stream is read) and re-recording (at least temporarily) an audio or video input stream at a rate faster than it is played back, the ease of use of a CD-based arrangement can be combined with much of the versatility of a hard-disk based arrangement.

In particular, a disc jockey can listen to or view the audio or video before it is played back (e.g. by being broadcast) and can select different audio or video input streams from e.g. CD players in the same manner as in a CD - based studio arrangement.

Furthermore it has been found that recordings can be written into mass storage from a CD player at a rate faster than real time (e.g. 20x real time) and subsequently played back successfully in real time, even if the CD or other recording medium is damaged (e.g. scratched) and thereby rendered unplayable from some conventional players.

Preferably the arrangement is arranged to analyse for faults in the audio or video

portion being written into mass storage and to re-write any faulty portion whilst lowering the input stream rate.

Preferably the arrangement is arranged to re-write any faulty portion using an input stream rate slower than first-mentioned rate (but preferably still faster than real-time).

Preferably the arrangement is arranged to detect successive identical data stream samples indicative of a defect in a data carrier (eg a CD) from which the audio or video input stream is read.

In one embodiment CD tracks which are required for immediate playback are downloaded to several temporary files at a rate faster than real-time. Each file will contain an exact length of audio (for example 30 seconds). As each audio file is written to disk, the waveform is analysed for two things -

i) moments when the stream has a run of identical samples (which indicates a scratched CD)

ii) peak audio level within that section.

If the waveform analysis suggests a scratch is detected then that 30 second portion is downloaded to disk again at a lower rotational speed of the CD. Once the first 30 second portion has been successfully analysed and written to disk (which should take around 3 seconds or less) the first few seconds of that portion are written to the RAM buffer and can be played on Pre-Fade Listen (PFL) or on-air.The remaining 30 second portions are downloaded in an identical fashion as a background process. The numerous files get sent to the RAM buffer in bursts where they are reassembled into a continuous data stream, which plays out in real time.

The main advantage of downloading to separate temporary files is that playback can commence once the first file (i.e. the first 30 seconds of CD track) has been fully written to disk, thus giving only a few seconds' delay from inserting the CD to starting playback. The other advantage is that if there is a scratch on the CD at a given point (eg at time 4.05) then only the affected subsequent 30 second portion (eg between 4.00 and 4.30) has to be downloaded again rather than the whole track. This is especially important if that track has started playback on-air before having been fully downloaded.

In practice, CDs are sometimes only loaded in the player at the last possible moment before being played to air. The disc jockey cannot wait for the whole track to

download - even ten seconds in a live situation is too long. This disadvantage is overcome by the above embodiment of the invention.

In the preferred embodiment the peak audio levels for each section are stored in RAM and when all sections have downloaded, the section with the highest peak audio level is used to decide whether extra gain should be introduced upon playback. If playback on-air (as opposed to PFL) has commenced before all the sections have been downloaded then default gain will be used.

Preferably the input stream rate of the subsequent portion of the digital audio or video input stream or of the different digital audio or video input stream is faster than real time, e.g. 4x or greater. For example if the input stream rate is 20x, a complete song (typically about 4 minutes in real time) can be completely recorded in about 10 to 15 seconds with only a few seconds' delay before playback can begin.

It is not essential for the audio or video input stream being written during playback of the audio or video input stream previously written into memory to be the same as (ie from the same source as) the previously written audio or video input stream; the time gained by the high-speed writing can be used in various ways under manual control (eg of the disc jockey) or under the control of an automatic scheduling sequence.

Preferably the arrangement includes a display representing one or more virtual players on screen. When the audio file representing the track is ejected from the virtual player, the system preferably checks whether to keep or delete the track. If it is to be kept, then the separate temporary files are saved to disk as a single audio file, which also contains the peak audio level data.

The invention also provides a method of operating a digital audio or video playback arrangement, the method comprising the steps of processing a digital audio or video input stream and writing at least a portion of the processed digital input stream into mass storage at a rate faster than real time, reading from mass storage at a rate faster than real time a previously written portion of the same or a different digital audio or video input stream and reading out via buffer means in real time said previously written portion.

In a related aspect the invention provides a method of operating a digital audio or video playback arrangement, the method comprising the steps of writing to mass storage, at a rate faster than real-time, a digital audio or video input stream from a removable data carrier, and simultaneously outputting at least one audio or video output stream, wherein said output stream is derived from the same or a different

digital audio or video input stream previously written to the mass storage.

In one embodiment in accordance with this aspect of the invention, tracks from a data carrier (eg a CD) which have previously been edited by the station can again be loaded from the original data carrier then played out with the desired edits reproduced from a data file storing edit information and produced during editing.

This file (herein called an EDL - Edit Decision List in the description of the preferred embodiment) typically functions as a template to reproduce all the edits at a future date, so when the CD track is again downloaded it is automatically modified according to the instructions set out in the EDL.

Preferably successive portions of the digital audio or video input stream are written to separate files, and said files are read out from mass storage and combined them into a real-time output stream.

Preferably the files are processed individually before being combined into said output stream.

Preferably the arrangement is arranged to analyse for faults in the audio or video portion being written into mass storage and to re-write any faulty portion whilst lowering the input stream rate.

Preferably any faulty portion is re-written at an input stream rate slower than said first-mentioned rate but still faster than real time.

Preferably there are detected any successive identical waveform samples indicative of a defect in a data carrier (e.g. a CD) from which the audio or video input stream is read.

It is envisaged that the invention will be applicable particularly to broadcast arrangements where ease of use and efficient use of time are of the essence, and not only to radio and television broadcast arrangements but also cable and satellite broadcast arrangements, particularly in view of their inherently digital nature.

In accordance with another aspect of the invention, there is provided a digital audio or video playback arrangement which is arranged to write into mass storage, at a rate faster than real time, two or more tracks of a digital audio or video input stream read from a recording medium and to generate at least one real-time output stream in which the order of the tracks is different from the order of the tracks read from the recording medium or to generate two or more real-time output streams in which

different tracks are playing simultaneously.

In this aspect the invention also provides method of operating a digital audio or video playback arrangement wherein two or more tracks of a digital audio or video input stream are read from a recording medium and written into mass storage at a rate faster than real time, and at least one real-time output stream is generated in which the order of the tracks is different from the order of the tracks read from the recording medium or two or more real-time output streams are generated in which different tracks are playing simultaneously.

In another aspect the invention provides a digital audio or video playback arrangement comprising at least one physical control panel which is aligned with and controls a virtual audio or video player represented on a display.

This has the advantage that the flexibility of a hard disk based system is retained in conjunction with the ease of use of a conventional hardware-based system.

Preferably successive portions of the digital audio or video input stream are written to separate files, said files are read out from mass storage and are combined into a real-time output stream.

Further preferred features of the invention are defined in the dependent claims.

A preferred embodiment of the invention is described below by way of example only with reference to Figures 1 to 10 of the accompanying drawings, wherein:

Figure 1 is a schematic block diagram of a digital audio broadcasting arrangement in accordance with the invention;

Figure 2 is a schematic block diagram of the processing, memory and storage arrangment of the arrangment of Figure 1;

Figure 3A is a timing diagram showing the reading and writing of digital audio streams in the arrangement of Figure 2;

Figure 3B is a timing diagram showing a variant of the reading and writing of the above digital streams in the arrangement of Figure 2 in response to the detection of a fault;

Figure 4 is a view of the left hand touchscreen monitor and corresponding left hand portion of the mixer control surface of the arrangement of Figure 1;

Figure 5 is a view of the right hand touchscreen monitor and corresponding right hand portion of the mixer control surface of the arrangement of Figure 1;

Figure 6 is a screen shot of the left hand touchscreen monitor in "NORMAL" (default) mode;

Figure 7 is a screen shot of the left hand touchscreen monitor in "LIBRARY" mode;

Figure 8 is a screen shot of the right hand touchscreen monitor in "STACKS" mode;

Figure 9 is a screen shot of the right hand touchscreen monitor in "RECORD" mode, and

Figure 10 is a screen shot of the left hand touchscreen monitor in "MASTER PFL" mode.

Referring to Figure 1, the arrangement comprises a personal computer (e.g. a Pentium® II) (1) running a multi-tasking operating system such as Windows 98 or Windows NT with a keyboard (not shown), a trackball (not shown) and two touchscreen colour monitors 6 and 7 which provide a graphical user interface.

The computer has an audio hard disk recording card (not shown) connected to an external audio interface module 4 with multiple inputs and outputs. The inputs can include a news feed, a traffic information feed, and a telephone feed for example and can include both digital and analogue sources. In order to accommodate the latter, the interface module 4 is provided with an analogue to digital converter (not shown).

The computer 1 is provided with fast hard disk storage 20 for audio (either local disks or a networked storage), a fast (e.g. 20x) CD-ROM drive 3 and a network connection to other PCs in the building (not shown) for exchanging music scheduling and log information.

A digital mixing module 5 is coupled to the computer via a data link. It should be noted that no audio signal passes through the mixing module - it is used purely as a remote control surface. Additionally the computer 1 is coupled to a master digital control panel 8 located at the right hand side of mixer control panel 5. Control panel 8 is provided with a MASTER PREFADE button 90, and RECORD, LIBRARY and STACKS mode selection buttons 80, 81 and 82 and a group of four navigation buttons N for navigating horizontally and vertically through the tracks displayed on

screen. The operation of control panel 8 will subsequently be described in detail.

Before describing the user interface aspect of the arrangement in more detail, the internal operation of the PC system 1 with its associated mass storage will be described with reference to Figures 2, 3A and 3B.

As shown in Figure 2, the PC 1 is provided with a high capacity hard disk 20 and is arranged to read in a digital audio stream from CD-ROM drive 3 (Figure 1) at nX real time e.g. 15X real time as indicated by input stream 100, under the control of microprocessor 500 (which is suitably a Pentium® II processor). The audio stream is fed into RAM 403 and checked for faults (e.g. a run of identical sample indicative of a scratch in the CD) and for maximum level by a suitable program executed in processor 500. After checking it is written sequentially to separate files F1, F2, F3, F4, F5, F6 (constituting one track F of the CD) and as a further sequence of files G1....G6 (constituting another track G of the CD) only the first file G1 having been written to disk at the stage shown in in Figure 2, each file comprising 30 seconds of audio. If a fault is detected in the audio stream before that particular 30 second portion of the audio stream has been fully written to disk, then the file is deleted and the process repeated at a lower speed (e.g. 4X) until all the separate files have been successfully written.

Once the first file F1 has been fully written to disk (i.e. has also been checked) then it will be possible to commence playback whilst the rest of the input stream from CD is still being processed and written to disk. Each separate stream of audio (whether for on-air playback or PFL) will require its own output buffer RAM memory region 401, 402, which will store approximately 5 seconds of audio. The output buffer memory regions 401, 402 may be separate memory modules (possibly located on the audio card) or may be discrete regions of a common memory e.g. the RAM associated with processor 500. to output buffer memory region 401 could already be playing back a different track which previously existed on disk. Small portions of the separate audio files F1, F2, F3... are read at nX real time eg 15X or 20X real time to output buffer memory region 401 where they are reassembled into a continuous data stream 404 (TRACK F) which is played out in real time to external audio interface 4. Similarly small portions of separate audio files G1, G2, G3....G6 which have been written to disk from another track G of the CD are read at nX real time to output buffer memory region 402 where they are reassembled into another data strream 405 which is similarly played out in real time as track G. The maximum level data (in respect of each track F and G) determined from the above processing is also fed to the audio card (not shown) of the PC and used to control the modulation levels of the respective digital signals in order to ensure optimum transmission.

Referring to Figure 3A, which shows the reading and writing operations of the CD (which generates the input stream 100), the hard disc 20, the RAM buffers 401 and 402 and the microprocessor RAM 403 at successive intervals between times t0 and t18, the above process will be described in more detail. Where a reading or writing process is faster than real time (n times real time) this is indicated by (nX). All the other reading and writing processes not qualified by "(nX)" are in real time.

As noted above, the CD is read at a rate of nX real time, eg 15 times faster than real time and this digital audio stream is read at the same rate to RAM 403 during period t0 - t1. At the same time, RAM 403 is read and the resulting stream is written to hard disc 20 (after checking for data integrity and level) as an audio file F1 containing e.g. 30 seconds of audio.

In the second period t1 - t2 an initial portion of audio file F1 is read from hard disk 20 to RAM buffer 401 where the resulting portions of the file reassembled and read out as real time audio stream 404. Thus playback of track F begins at t1, which may be only a few seconds after reading the input stream 100 from the CD. It should be noted that any combination of audio files (including files previously written) can be read from disk 20, distributed between the RAM buffers 401 and 402 and reassembled in any order under microprocessor control, so that, for example, tracks from the CD can be played simultaneously as separate output streams and can be played in a different order from that of the CD. During this period a further audio file F2 is written to disk 20 whilst F1 is being read. There may be a rapid alternation between reading and writing to disk during this period or the reading and writing can be truly simultaneous by virtue of the multi-tasking capability of the operating system.

In the third period (t2 - t3) a similar process occurs, the only difference being that a new file F3 is written to disk whilst the RAM buffer 401 still has enough data left to continue reading out the initial portion of F1 in real-time. It is assumed for the sake of simplicity that there are only six 30 second files F1 to F6, which correspond to track F on the CD.

In the fourth period (t3 - t4) the next portion of audio file F1 is read from hard disk 20 to RAM buffer 401. During this period a further audio file F4 is written to disk 20.

In the fifth period (t4 - t5) a new file F5 is written to disk whilst the RAM buffer 401 still has enough data left to continue reading out the subsequent portion of F1 in real-time.

In the sixth period (t5 - t6) the next portion of audio file F1 is read from hard disk 20 to RAM buffer 401 as real-time playback continues at output stream 404. During this period the final audio file F6 is also written to disk 20.

In the seventh period (t6 - t7) all the separate files have been written to disk and real-time playback will continue via RAM buffer 401.

In the eighth period (t7 - t8) another track from a CD is written to disk as file G1. Playback of file F1 continues as the next portion is read from disk and written to RAM buffer 401.

In the ninth period (t8 - t9) the next portion of the CD track is written to disk as file G2. Playback of file F1 continues via RAM buffer 401 and the initial portion of file G1 is written to RAM buffer 402 where it can be output in real-time. This playback of track G begins at time t9.

This process continues for the next few periods until t13 - t14 when all files G1-G6 have been written to hard disk 20. It should be noted that due to the high speed transfer of data (assuming a transfer speed of 15 times real-time and a disk file duration of 30 seconds) it is not until period t15 - t16 that the initial portion of file F2 is read from disk and written to RAM buffer 401.

The sequence shown in Figure 3B is similar to that of Figure 3A except that it is assumed a scratch (corresponding to a sequence of identical samples) is detected in the CD during writing file F2 to hard disk 20 during the second period t1 - t2. Accordingly this file is re-written at a lower speed (n'X) real time (e.g. 5X) in the third period t2 to t3. It should be noted that playback of file F1 had already commenced in the period t1 - t2.

It can be seen from comparing Figure 3A and 3B that as the defect was discovered in the second portion of the input stream (i.e. in file F2) playback of file F1 has not been affected at all and can still playback in real-time via RAM buffer 401. As mentioned before, it is not until period t15 - t16 that file F2 is read from disk and written to the RAM buffer, so there is sufficient time to download file F2 without defects as shown in Figure 3B.

The main advantage of downloading to separate temporary files F1, F2, F3... is that playback can commence once the first file (i.e. 30 second portion) has been fully written to disk thus giving only a few seconds' delay (eg about 1.5 seconds in this case) from inserting the CD to starting playback. The other advantage is if there is a

scratch on the CD at 4.05 (for example) then only the affected 30 second portion (between 4.00 and 4.30) has to be downloaded again rather than the whole track. This is especially important if that track has started playback on-air before having been fully downloaded.

The peak audio levels for each file F1, F2, F3... are stored in RAM and when all sections have downloaded the section with the highest peak audio level is used to decide whether extra gain should be introduced upon playback. If playback on-air (as opposed to PFL) has commenced before all the sections have been downloaded then default gain will be used.

The concept of downloading all CDs to hard disk introduces another preferred innovative feature that conventional CD players will never be able to match. Because the desk's routing is effectively controlled by software, it will be possible to listen to the end of any track using the PFL (Pre Fade Listen) facility (provided by one of the buttons B shown in Figure 4) while the same track is currently playing out to air. The same will be true for commercial break stacks and jingles.

Downloading to disk whilst checking for sequences of identical samples as described above has another advantage: CDs will never skip on air. Testing has shown that even downloading at 8x real time has resulted in perfect rendition of tracks which are otherwise unplayable on some conventional CD players.

Because the system checks the peak level of the selected track, additional gain can be automatically added for quiet tracks upon playback. If the track starts to play on-air before totally downloaded (and therefore before it is fully checked for peak level) then the default gain will be used but the peak level value will still be written to the audio file generated and will be used if the track is played in the future.

Several radio stations choose to edit tracks before broadcasting (either for removing bad language or to fit in with the station's style). When the track is first edited a data file is usually generated called an EDL (Edit Decision List). In accordance with a preferred feature of the invention the new edited version is automatically recreated when the original CD track is reloaded by using the EDL data. This effectively means that tracks which require editing before playback can be treated in the same way on the system as non-edited tracks.

In accordance with a further preferred feature, when a track is loaded in from CD, the present arrangement will automatically look up the programme schedule for the next four days (or other specified time) and check whether any track(s) from the same CD are scheduled. If they are to be played and currently have a MISSING

status then they are also loaded to disk immediately after the original track has been downloaded.

For example, the breakfast show disc jockey scrolls down the schedule and sees that the next
track to be played is Track 5. The status column displays MISSING so he puts the requested CD into the CD-ROM drive. Track 5 immediately starts to download to hard disk 20.

Meanwhile the program loaded in computer 1 finds that in three days time the late evening show is scheduled to play track 8 from the same CD, the status on this track is also MISSING. So, once Track 5 has finished downloading, the arrangement automatically downloads Track 8 for future use. Because this process is so quick (around 15 seconds), the breakfast show disc jockey will probably be unaware that the extra download ever happened.

A couple of days pass, and the late show disc jockey is doing his show (maybe in a different studio, maybe even on the station's alternative output). He scrolls down the schedule, sees that Track 8 is scheduled. The status of the track is AVAILABLE. He hits the LOAD button on DISC 2 and instantly plays the track to air that the breakfast show disc jockey unwittingly loaded in for him.

Even though each extra track for future use will only take about 10-15 seconds to download there is of course the option to cancel the extra loading if the on-air disc jockey needs to get on with loading his own tracks. In this case the future event will still show MISSING on the status line and will have to be loaded from CD during the show.

The preferred arrangement also features automatic track storage management. Once a track has been played out on-air, the automatic track storage facility will check the programme schedule for the following period e.g. four days and see whether that track is played again (even if it appears on the programme schedule for the station's alternative output). If it is to be played again within this specified time then the track is kept on the system and will be displayed as AVAILABLE on display area D when the disc jockey comes to play it in the future. If it is not played again then the track is deleted from the hard disk automatically. So for instance, if it is played again in two weeks time the track will have to be loaded from CD. It makes little sense to have tracks sitting around on the system and using disk space if they are rarely played.

Playlisted tracks are the exception to this; they will remain on the system until manually deleted by the system administrator.

This automatic and unique way of limiting the number of music tracks that need to be stored on the hard disk at any one time is a major advantage of the preferred embodiment. It essentially gives the station all the flexibility of a hard disk based system without the disadvantages of a member of staff required to load all the tracks onto the system and the ever increasing amount of disk storage required to hold the tracks.

It should be pointed out that the preferred embodiment allows tracks to be loaded in advance without loading into a virtual player. This can either be done on the same system or on a separate PC, which has a fast CDROM drive and is networked to the main hard disk storage. If tracks are loaded in advance in this way, each track will be directly downloaded as one complete file rather than numerous temporary files. Differently scheduled tracks from the same CD would be loaded at the same time.

Referring now to Figures 4 and 5, the mixing module 5 is typically in the form of two mixing panels 5L and 5R (Figures 4 and 5 respectively) mounted in a desk (not shown) with space for scripts etc in the middle. The panels are ergonomically angled towards the disc jockey and are divided horizontally into channels C1 to C7 and C8 to C13 respectively as described above. Each channel has a standard fader F that is also motorised and also has illuminated pushbuttons B for LOAD, AUTO, CUE, PFL (Pre-Fade Listen) and START.

The channels are modular so different requirements can easily be accommodated. The illuminated pushbuttons will differ according to the type of channel.

The channels C1 to C13 (Figures 4 and 5) are (from left to right):

C1 EFFECTS (internal effects output from audio card)

C2 DISC 1

C3 DISC 2

C4 DISC 3

C5 MIC 3

C6 MIC 2

C7 MIC 1

There is then a script space between two panels, followed by:

C8 QUICKFIRE

C9 AUX 1

C10 AUX 2

C11 CART 1

C12 CART 2

C13 CART 3

The function of a mixer channel C2, C3 or C4 (Figure 4) or C11, C12 or C13 (Figure 5) will now be described. The CD track or cart can be started by pressing the START button B which will illuminate green when in playback mode. If the CUE button B is pressed then the track will stop playback and reset to the chosen start point (which is by default the start of audio but can be changed) the CUE button will illuminate amber when reset and ready.

If a channel has its AUTO button B lit then its associated player will automatically start after the previous event finishes. Players will automatically start in order from left to right but if any carts have AUTO activated then they will take priority over discs.

For example if Disc 1 is playing and both Disc 2, Cart 1 and Cart 2 are loaded and have their AUTO buttons lit, when Disc 1 finishes, the players will automatically start in this order: Cart 1, Cart 2 followed by Disc 2.

The QUICKFIRE fader will be described subsequently.

Behind mixing panel 5L is touchscreen colour monitor 6, which has three virtual CD players VP1, VP2 and VP3 at the bottom of its screen aligned with channels C2, C3 and C4 respectively. Similarly touchscreen monitor 7 has virtual cartridge players VP4, VP5 and VP6 which correspond to and are situated directly above the CART 1-3 channels (C11, C12 and C13) on the right hand mixing panel 5R. Uniquely, the disc jockey can see at a glance which player is operating and the state of its associated mixer channel.

Each on screen virtual player has a current status display L at the bottom (which shows READY/PLAY/PAUSE etc) and above that is a visual display D1 of the current position (time) within the audio file. Above display D1 is a representation V1 of the disc being played by each virtual player with audio file details displayed such as track title and artist. Display D1 displays either an E (for tracks that end suddenly) or an F (for tracks that fade out). Intro countdowns are displayed with tenths of a second displayed after the "seconds" display. All the above timing information is either included as part of the music schedule data or is retrieved from the station's CD library database.

As shown in Figure 4 and more clearly in Figure 6, above the virtual disk players on the left hand screen 6 are six "soft" buttons SB1 to SB6 (i.e. touch-sensitive regions of the screen) arranged horizontally across the screen. These allow control of the software and their functions will change depending on what mode the screen is in. The following description relates to the default or "NORMAL " mode.

Above the soft buttons is the main programme schedule S (Figures 4 and 6) which can be scrolled up and down with the trackball (not shown). This central area is also where scripts which are to be read by the disc jockey will appear when required. The programme schedule area S contains information for each programmed event such as source, status and title.

The status displayed for each event will be one of the following:

i) ON AIR - the event (track/cart/commercial etc) is currently being broadcast on air.

ii) READY - the relevant event has been loaded into a player and is ready to be played on-air.

iii) AVAILABLE - the event already exists on the hard disk/s for loading into a player.

iv) MISSING - only applies to tracks downloaded from CDs - the event is NOT currently on the hard disk/s and will need to be downloaded from CD.

If the LOAD NEXT soft button SB1 is pressed then the next AVAILABLE event, which is not either on-air or ready, is automatically loaded into the next available player of the correct type (whether disc or cart event). The event's status will change to READY and the disc/cart can be previewed on PFL (Pre-Fade Listen) or played out on air immediately.

If the LOAD NEXT soft button SB1 is pressed and the next event which is not either on-air or ready is shown as MISSING then the drawer of the CD-ROM player 3 will automatically open so the correct CD (as identified under the SOURCE column) can be inserted.

The system will check that the correct CD has been inserted (by reading the CD's serial number and/or index information) and will automatically start downloading the correct track in the manner described above with reference to Figures 2, 3 and 3A. Within a few seconds the channel's CUE button will illuminate, the artist/title will be displayed on screen, relevant timings will be displayed (on D1 and D2) and when the downloading (including re-recording of any files with faults) has been completed satisfactorily the event's status will change to READY on both the programme schedule and the player's status display L.

The fact that the track title will be displayed on the player above the relevant channel greatly reduces the chance of the disk jockey starting the wrong player by accident.

If the disc jockey wants to play a track not on the programme schedule then he presses the LOAD button B (Figure 4) on the desired player and can choose to either insert a CD for downloading or select from the library of tracks already held on hard disk. Tracks/carts are ejected from the virtual players by holding the CUE and LOAD buttons B (Figure 4) at the same time.

Above the programme schedule area S is displayed the current time in written form (e.g. twenty-five minutes past four) and also digital form with seconds. There is also a countdown in
minutes and seconds until the next top of the hour (eg minutes and seconds remaining until 4.00pm exactly).

Referring to Figures 5 and 8, the right hand portion 5R of the control panel and associated touch screen monitor 7, which are used for playing virtual cartridges, will now be described. Above the virtual cart players VP4, VP5 and VP6 (which function identically to the virtual disc players VP1 to VP3 apart from not displaying whether a track ends or fades) on the right hand screen 7 are displayed representations V2 of the virtual cartridge being played by each virtual player with audio file details displayed such as track title and artist which are analogous to the representations V1 of Figures 4 and 6. Above these are displayed three "next slots" V3 which similarly represent the next cart to be played after the current cart for each player when carts have been stacked up in sequence. Above the "next slots" is displayed a virtual cart library R.

There are provided:

i) Virtual carts which are light blue in colour and as their name suggests, contain a single audio file, and

ii) Virtual stacks, which are green in colour and contain a group of carts. These are ideal for commercial breaks so several carts can be grouped in advance onto a single stack.

Because each cart player is virtual it can have differently routed outputs according to requirements, so catering for split-frequency stations is no problem. For instance both AM and FM commercial stacks could be played from a single cart/stack, be controlled from the same fader whilst still going to the separate respective outputs.

Additionally, the system features a MASTER PFL mode, selected by button 90 on panel 8,} which allows the disc jockey to do a completely different mix on the prefade output without affecting what is going out on the main mixer output (i.e. on air). A screenshot of MASTER PFL mode is shown in FIGURE 10.

In the default mode, each channel's PFL button B (Figures 3 and 4) works in a conventional manner for previewing tracks and carts etc. However when the MASTER PFL mode is selected the faders F of any on air sources will physically close (all the faders are motorised for this purpose), and currently loaded players will empty. This allows the disc jockey to pre-record a telephone call, promotional script etc using any of his sources. He can even use the same players that are currently playing a track/cart to air on the main output.

In order to alert the disc jockey that MASTER PFL is on (so he does not mistakenly believe that what he is listening to is being broadcast) the layout of the schedule screen S will change. The event currently on-air will move to the top line 300 and the next three events will be displayed below. The fifth line 301 will change to a blue colour and display "Master Prefade On" which will move across the screen. This fifth line will also help separate the on-air events from every other event displayed below which can be scrolled up and down as described above.

Once the disc jockey has finished and switches MASTER PFL off, the faders return to their original position to display the on-air output.

MASTER PFL also provides the facility to record segues (in the manner of a script for controlling a program with a pre-recorded series of commands) which are further down the programme schedule. Everything that the disc jockey does will be

remembered and recalled at the appropriate time when the arrangement is using the FULL AUTO facility.

In order to do this the disc jockey scrolls the schedule in region S of screen 6 (Figure 10) to a transition line TL (found between two events) and presses RX TRANS button SB5 on this screen. The desk will instantly switch into MASTER PFL mode and the players will automatically be loaded with the outgoing and incoming track plus any cart's specified in the transition.

The disc jockey will then press RECORD button 82 and the last 20 seconds or so of the outgoing track will start playing. In addition the clock displays will change to show what the time really would be at this point in the future. Thus "time checks" in the future are provided for. If the disc jockey just wants to do a straight music segue, the program will remember the point the next track was started and all the fader positions when it comes to the actual on-air time. If the disc jockey wants to do a link, then opening either mic fader F will automatically start recording the mic output which will be later replayed as a cart. If he is not happy with the result, he can keep recording the transition until satisfied.

The above process is completely transparent and allows the disc jockey to record some of his show in advance, including links if he wishes. It is believed that no other system currently offers this degree of flexibility and ease of use.

Additionally, a FULL AUTO function can be selected by toggling a full auto/manual button 180. The system will follow the schedule in column SC of region S of the left hand screen 6 (Figure 4), load tracks and carts and automatically transition between events. The background of the clock area T of the left hand screen will change to red when full auto mode is activated.

The right hand screen 7 operates in three basic modes:

i) In LIBRARY mode as a cart library (selected by LIBRARY button 80 on the master control panel 8) to select which cart to load into the player. A screen shot of LIBRARY mode is shown in Figure 7.Each page holds 18 carts as shown in region R and pages are scrolled through using navigator buttons N. To load into a player, the LOAD button B is pressed on the desired player's channel and the required cart touched on the screen. It is also possible to load more than one cart into the same player at the same time. This is done by continuing to hold down the LOAD button B whilst the required cart is touched on the screen. If multiple carts are loaded into the same player this way, they will stack vertically (the next one to play now being visible in the "next slot" V3) and can be viewed and reordered by switching to

STACKS mode as described below.

Carts can also be played out directly from the library on the QUICKFIRE fader channel C8 just by touching the title. More than one cart can be played simultaneously in this mode but all carts will appear on the QUICKFIRE fader. Once a cart has been started on the QUICKFIRE fader, the label will change to a countdown of remaining time. A second touch on the playing cart will fade it out.

Panel 8 features four navigation buttons N which are used to navigate horizontally and vertically through the cart library screens when in LIBRARY mode.

ii) In STACKS mode (as shown in Figure 8) for viewing the progress of cart stacks (selected by STACKS button 81 on the master control panel 8). This will display the stack title ST at the top (only in the case of a pre-programmed stack having a title) and below that is a pile of the carts contained within the stack. There is also a CHAIN button CH which when touched ensures that each cart in the stack will automatically play in sequence after the previous cart finishes. The bottom cart in the stack will drop into the player and the stack will move down. Some stations like the ability to reorder the carts in a stack at anytime before playing to air, which is made possible in this mode by simply dragging the carts to a new position within the stack.

iii) In RECORD mode (selected by button 82) for recording to hard disk. A screenshot of RECORD mode is shown in Figure 9. It is possible to select any number of sources for recording and there are provided controls 100, 101, 102, 103, 104 and 105 for REWIND, STOP, PAUSE, PLAY, RECORD and FAST FORWARD respectively. It is also possible to provide an editing screen for editing the recorded audio by touching an EDIT button 106. The edit screen may be conventional and therefore is not shown. A SAVE button 107 is provided for saving the recording.

It should be noted that although an embodiment has been described in which a hard disk is used as the mass storage, any non-volatile memory of sufficent capacity for audio or video is suitable; other non-disk based memory types may become available in the future.

It should be noted that many of the preferred features of the described embodiment are novel and inventive in their own right and accordingly these features are not tied to the features of claim 1 or any other independent claim and are presented as independent inventions.

Claims

1. A digital audio or video playback arrangement arranged to process a digital audio or video input stream and to write at least a portion of the processed digital input stream into mass storage at a rate faster than real time, to read from mass storage at a rate faster than real time a previously written portion of the same or a different digital audio or video input stream and to read out via buffer means in real time said previously written portion.

2. A digital audio or video playback arrangement arranged to write to mass storage, at a rate faster than real-time, a digital audio or video input stream from a removable data carrier, and simultaneously to output at least one audio or video output stream, said output stream being derived from the same or a different digital audio or video input stream previously written to the mass storage.

3. A digital audio or video playback arrangement as claimed in claim 1 or claim 2 which is arranged to write successive portions of the digital audio or video input stream to separate files, to read out said files from mass storage and combine them into a real-time output stream.

4. A digital audio or video playback arrangement as claimed in claim 1 or claim 2 or claim 3 which is arranged to process said files individually before recombining them into a real-time output stream.

5. A digital audio or video playback arrangement as claimed in any preceding claim which is arranged to generate two or more simultaneous real-time output streams from the processed data.

6. A digital audio or video playback arrangement as claimed in any preceding claim wherein said processing includes the detection of data integrity.

7. A digital audio or video playback arrangement as claimed in claim 5 which is arranged to re-read any faulty portion of the input stream at a lower rate than said first-mentioned rate and to re-write it to mass storage.

8. A digital audio or video playback arrangement as claimed in claim 7 as dependent on claims 6 and 4 which is arranged to re-write any faulty file to mass storage.

9. A digital audio or video playback arrangement as claimed in any preceding claim

wherein said processing includes the detection of peak level or dynamic range.

10. A digital audio or video playback arrangement as claimed in any preceding claim which is programmable to associate one or more playback parameters with a written portion of the digital audio or video input stream and arranged to play that written portion in accordance with its associated one or more playback parameters.

11. A digital audio or video playback arrangement which is arranged to write into mass storage, at a rate faster than real time, two or more tracks of a digital audio or video input stream read from a recording medium and to generate at least one real-time output stream in which the order of the tracks is different from the order of the tracks read from the recording medium or to generate two or more real-time output streams in which different tracks are playing simultaneously.

12. A digital audio or video playback arrangement as claimed in claim 11 which is arranged to write successive portions of the digital audio or video input stream to separate files, to read out said files from mass storage and recombine them into at least one real-time output stream.

13. A digital audio or video playback arrangement as claimed in claim 10 or claim 11 which is arranged to check data integrity of the input stream and to re-read the input stream at a different rate if necessary to achieve data integrity.

14. A digital audio or video playback arrangement as claimed in any of claims 10 to 12 which is arranged to detect peak level or dynamic range of the input stream and to utilise this data to process the output stream.

15. A digital audio or video playback arrangement comprising at least one physical control panel which is aligned with and controls a virtual audio or video player represented on a display.

16. A digital audio or video playback arrangement as claimed in claim 15 comprising two or more fader panels aligned with respective audio or video players represented on a common display.

17. A digital audio or video playback arrangement as claimed in claim 14 or claim 15 wherein one or more of the following items of information is arranged to be displayed in association with a virtual audio or video player on screen: operational status of the virtual player, title of track being played, timing information relating to such a track, and tracks available for playback.

18. A digital audio or video playback arrangement as claimed in any of claims 15 to 17 wherein the display is a touch-screen display having virtual buttons enabling the user to control each virtual audio or video player.

19. A digital audio or video playback arrangement as claimed in claim 18 wherein two or more modes of operation of the players are selectable by the user and the controls and/or information relating to an audio or video player displayed on screen change according to the mode selected.

20. A digital audio or video playback arrangement as claimed in any preceding claim which is controlled by a programmed microprocessor arranged to play a user-selectable sequence of audio or video tracks in at least one virtual audio or video player.

21. A digital audio or video playback arrangement as claimed in any of preceding claim which is arranged to write into mass storage, at a rate faster than real time, one or more tracks of a digital audio or video input stream read from a recording medium and to associate said one or more tracks with one or more virtual audio or video players which are arranged to control playback of at least one said track in real time.

22. A digital audio or video playback arrangement as claimed in claim 21 which is arranged to control playback of at least one said track in real time whilst writing into mass storage, at a rate faster than real time, further tracks of the digital audio or video input stream or a different digital audio or video input stream.

23. A playback arrangement as claimed in any preceding claim comprising a digital interface arranged to receive selectively at least one of a plurality of digital audio or video input streams.

24. A playback arrangement as claimed in claim 23 comprising at least one digital audio or video player arranged to provide at least one of said digital input streams.

25. A playback arrangement as claimed in any preceding claim wherein the mass storage comprises a magnetic or magneto-optic recording medium.

26. A playback arrangement as claimed in any preceding claim which is arranged to broadcast audio and/or video signals over an electronic broadcast medium.

27. A playback arrangement as claimed in any preceding claim comprising user-operable means for playing a first portion of audio and/or video from said digital input stream at one output port whilst playing a second portion of audio and/or video

from said digital input stream at another output port.

28. A playback arrangement as claimed in claim 27 wherein the user-operable means comprises a pre-fade listen facility arranged to play said first portion of audio and/or video selectively to the user whilst broadcasting said second portion of audio and/or video.

29. A playback arrangement as claimed in any preceding claim comprising at least one display arranged to provide a graphical user interface for controlling the arrangement.

30. A playback arrangement as claimed in claim 29 wherein the display is arranged to display representations of controls and/or parameters of one or more sources of the digital input stream.

31. A playback arrangement as claimed in claim 30 wherein the representations on screen are grouped, each group relating to a respective selectable digital input stream, and the groups are aligned with respective physical control panels controlling the respective digital input streams.

32. A playback arrangement as claimed in any of claims 29 to 32 wherein the display is a touch-screen display.

33. A playback arrangement as claimed in any preceding claim, comprising means for displaying a schedule of audio and/or video tracks to be played and for indicating the status of the tracks.

34. A studio mixer comprising a digital audio or video playback arrangement as claimed in any preceding claim.

35. A method of operating a digital audio or video playback arrangement the method comprising the steps of processing a digital audio or video input stream and writing at least a portion of the processed digital input stream into mass storage at a rate faster than real time, reading from mass storage at a rate faster than real time a previously written portion of the same or a different digital audio or video input stream and reading out via buffer means in real time said previously written portion.

36. A method of operating a digital audio or video playback arrangement the method comprising the steps of writing to mass storage, at a rate faster than real-time, a digital audio or video input stream from a removable data carrier, and simultaneously outputting at least one audio or video output stream, wherein said

output stream is derived from the same or a different digital audio or video input stream previously written to the mass storage.

37. A method as claimed in claim 35 or claim 36 wherein successive portions of the digital audio or video input stream are written to separate files, and said files are read out from mass storage and combined them into a real-time output stream.

38. A method as claimed in claim 37 wherein the files are processed individually before being combined into said output stream.

39. A method as claimed in any of claims 35 to 38 wherein two or more simultaneous real-time output streams are generated from the processed data.

40. A method of operating a digital audio or video playback arrangement wherein two or more tracks of a digital audio or video input stream are read from a recording medium and written into mass storage at a rate faster than real time, and at least one real-time output stream is generated in which the order of the tracks is different from the order of the tracks read from the recording medium or two or more real-time output streams are generated in which different tracks are playing simultaneously.

41. A method as claimed in claim 40 wherein successive portions of the digital audio or video input stream are written to separate files, said files are read out from mass storage and said files are combined into a real-time output stream.

42. A method as claimed in claim 40 or claim 41 wherein two or more simultaneous real-time output streams are generated from the processed data.

43. A method as claimed in any of claims 35 to 42 wherein the audio or video read out from mass storage is broadcast over an electronic broadcast medium.

44. An audio or video playback arrangement substantially as described hereinabove with reference to Figures 1 to 10 of the accompanying drawings.

45. An method of operating an audio or video playback arrangement, the method being substantially as described hereinabove with reference to Figures 1 to 10 of the accompanying drawings.

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Application No: GB 9823050.1 **Examiner:** Frank Moeschler
Claims searched: 1-14, 20-45 **Date of search:** 6 January 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G5R RGB, RGC, RLA, RB33

Int Cl (Ed.6): G11B 20/00, 20/10, 20/18, 27/00

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0615242 A2	(SONY) See Col 2 line 28 - Col 3 line 29	1-4, 10, 21, 22, 25, 35-38.
Y	WO 91/15845 A1	(COMPUTER CONCEPTS) See Page Fig 1.	26, 28
X,Y	US 5719985	(ITO) See Col 5 line 55 - Col 10 line 67	X: 1-5, 10-12, 20-25, 27, 29-42 Y: 6-9, 13, 14, 26, 28
X	US 5646921	(YOKOTA) See Cols 12-14	1-4, 10, 21, 22, 25, 35-38.
Y	US 5612933	(ISO) See Col 3 lines 15-24 and Col 11 line 47- col 12 line 10.	6-9, 13, 14

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Application No: GB 9823050.1
Claims searched: 15 - 19

Examiner: Anna Mackisack
Date of search: 30 April 1999

Patents Act 1977
Further Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): G5R (RB81 RGC RQA) H4J (JGP)

Int Cl (Ed.6): G11B 15/00 15/02 19/00 19/02 27/02 27/028 27/031 27/032 27/034 27/036 27/038; H04R 3/00

Other: Online: JAPIO WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
E, X	GB 2326516 A	BRITISH BROADCASTING CORPORATION - see especially fig. 3	15, 17, 19
X	GB 2323699 A	SONY CORPORATION - see especially figs. 1 and 3	15, 17, 19
X	GB 2296600 A	SONY CORPORATION - see especially figs. 1 and 7	15 - 17, 19
X	EP 0262991 A2	INTERAND CORPORATION - see abstract and fig. 1	15, 17, 18
X	US 5237648 A	APPLE COMPUTER - see whole document	15
X	JP 080031075 A	SONY CORPORATION - see fig. 1 and also WPI Abstract Accession No. 96-153916/16	15, 18

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.